1998 Mars Surveyor Program

MR Characteristics & Requirements Document

A Summary of the Mars Relay Lander & Orbiter Characteristics and Requirements

Revision 1

15-May-96

Revision	Date	Description	Affected
1	15-May-96	Updated to correct functionality.	page 3

MR Characteristics & Requirements Document

1. Introduction

The following is a summary of the Mars Balloon Relay (MBR) interface characteristics and requirements. The MBR (also known as the Mars Relay, MR) will be on the Mars Global Surveyor (MGS)-96 mission. The referenced (attached) document was provided for MGS and, consequently, provides detailed interface information from an orbiter perspective. Section 3 of this document provides a lander perspective on what is needed to communicate with the orbiting MBR.

2. References

Ribes, André, Mars Relay, Major Physical Characteristics Description and Interface Requirements, CNES Briefing, 31-Aug-94

3. MBR Characteristics & Interface Requirements

Lander relay links shall be designed to use the following relay link capabilities.

a. The MR uses a 16s cycle termed BTTS (Balloon Telemetry Time Slot). The BTTS can either : 1) have 14s of Request Command (RC) subcarrier and 2s of pure carrier, if there is no response from a lander, or, 2) if there is a response from a lander, have a transmission cycle of 15s (combination of RC and telemetry command (TC)), followed by 1s of pure carrier. (See Figure 3-1 for link protocol; see Table 3-1 for subcarrier frequencies.)

Table 3-1 MR Beacon Subcarrier Frequencies

Telemetry Command (TC)	Request Command (RCx)
1376.34 ± 0.002 Hz	RC1: 1484.06 ± 0.002 Hz RC2: 1137.78 ± 0.002 Hz RC3: 1028.11 ± 0.002 Hz

b. Acquisition/Transmission Sequence

(1) The orbiter, via the MR, broadcasts a frequency modulated beacon at 437.1000 MHz. The orbiter-to-lander beacon signal is modulated with one of three possible sets of request command (RCx).

(2) Upon detection of the RCx, the lander transmits a pure carrier to allow the MR to synchronize to the carrier. This is followed by the lander sending an acquisition preamble (Viterbi PN sequence) that allows the MR to synchronize and lock its Viterbi decoder. This preamble can be any random bit sequence including a sufficient number of convolutionally encoded bits.

(3) After locking the carrier and bit synchronizer, the MR opens a time window and checks for the Viterbi output quality. When the minimum quality is reached (i.e., -126dBm for Rate 1 (R1), -114dBm for Rate 2 (R2)), the MR transmits the TC to the answering lander.

(4) After detection of the TC, the lander completes sending the last Viterbi pattern sequence, and begin sending the lander telemetry.

(5) Loss of signal at the MR terminates the **Telemetry Command (TC). This in turn stops the lander from transmitting. The MR sends a pure carrier until the beginning of the next BTTS.**

c. The link margin is 4dB over a = 10 minute relay interval.

d. The communication orbiter elevation mask shall be 20° for ± 60° latitudes, and 5° for ± 90° latitudes (i.e., ice caps).

e. The Mars Relay can receive on either F1 = 401.5275 MHz or F2 = 405.6250 MHz. The stability of F1 and F2 must be $\pm 1 \times 10^{-7}$ over 1 s, $\pm 1 \times 10^{-6}$ over 1 min., $\pm 2 \times 10^{-6}$ over 15 min., $\pm 7 \times 10^{-6}$ over 15 days, and $\pm 1 \times 10^{-5}$ worse case.

f. Modes

(1) The MR can communicate with three different landers in the same beamwidth without jamming. The MR will be commanded by uplinked sequence commands (from ground controllers to the orbiter) to select one lander or two alternating landers.

(2) The available modes are identified in Table 3-2. Three categories of landers are identified: Lander 1 (L1), Lander 2 (L2), and Lander 3 (L3).

(3) The data rate is selected on the orbiter by sequenced commands. Permissible data rates of 8 and 128 kb/s before convolutional encoding are:

If F1 is used: R1 = 8003 b/s , R2 = 128038 b/s
If F2 is used: R1 = 8085 b/s , R2 = 129345 b/s

(4) Data rate and carrier frequency are coherently related to each other. The coherency ratio is 3136 for R2 and 3136x16 for R1.

g. Viterbi coding uses a convolutional code of 7-1/2. The modulation is bi-phase L with modulation index of 60°± 10%. Worst case losses are: data loss, -1.5dB; carrier loss, -7.8dB.

h. Doppler capability is contained in the Mars Relay and may be used for lander location determination.

I. The MR on the '96 MGS provides one-way (lander-to-orbiter) data transmission only; no command link from the lander-to-orbiter is available via the MR. The command link for the 1998 Orbiter is to be provided by the '98 lander and orbiter Contractor(s), providing two-way UHF communication between the '98 orbiter and Mars surface element(s).

Table 3-2. Mars Relay (MR) Modes

Mode Number	Lander	Beacon	Data Rate	RF Frequency	Viterbi Decoder	Calling Order (Subcarrier)
M1	L1 only	On	R1	F1	On	RC1/TC
M2	L1 only	On	R1	F1	Off	RC1/TC
M3	L2 only	On	R1	F1	On	RC2/TC
M4	L2 only	On	R1	F1	Off	RC2/TC
M5	L1/L2 alternate	On	R1	F1	On	RC1/TC-RC2/TC etc.
M6	L3 only	On	R1	F1	On	RC3/TC
M7	L3 only	On	R1	F1	Off	RC3/TC
M8	L3 only	On	R2	F2	On	RC3/TC
M9	L1/L2 alternate	On	R1	F1	Off	RC1/TC-RC2/TC etc.
M10	L1/L3 alternate	On	R1	F1/F2	On	RC1/TC-RC3/TC etc.
M11	L1/L3 alternate	On	R1	F1/F2	Off	RC1/TC-RC3/TC etc.
M12	L1/L3 alternate	On	R2	F1/F2	On	RC1/TC-RC3/TC etc.
M13	L3 only	On	R1	F2	Off	RC3/TC
M14	L1 only	On	R2	F1	On	RC1/TC
M15	Test 1	On	R1	F1	On	No modulation
M16	Test 2	Off	R1	F1	Off	NA

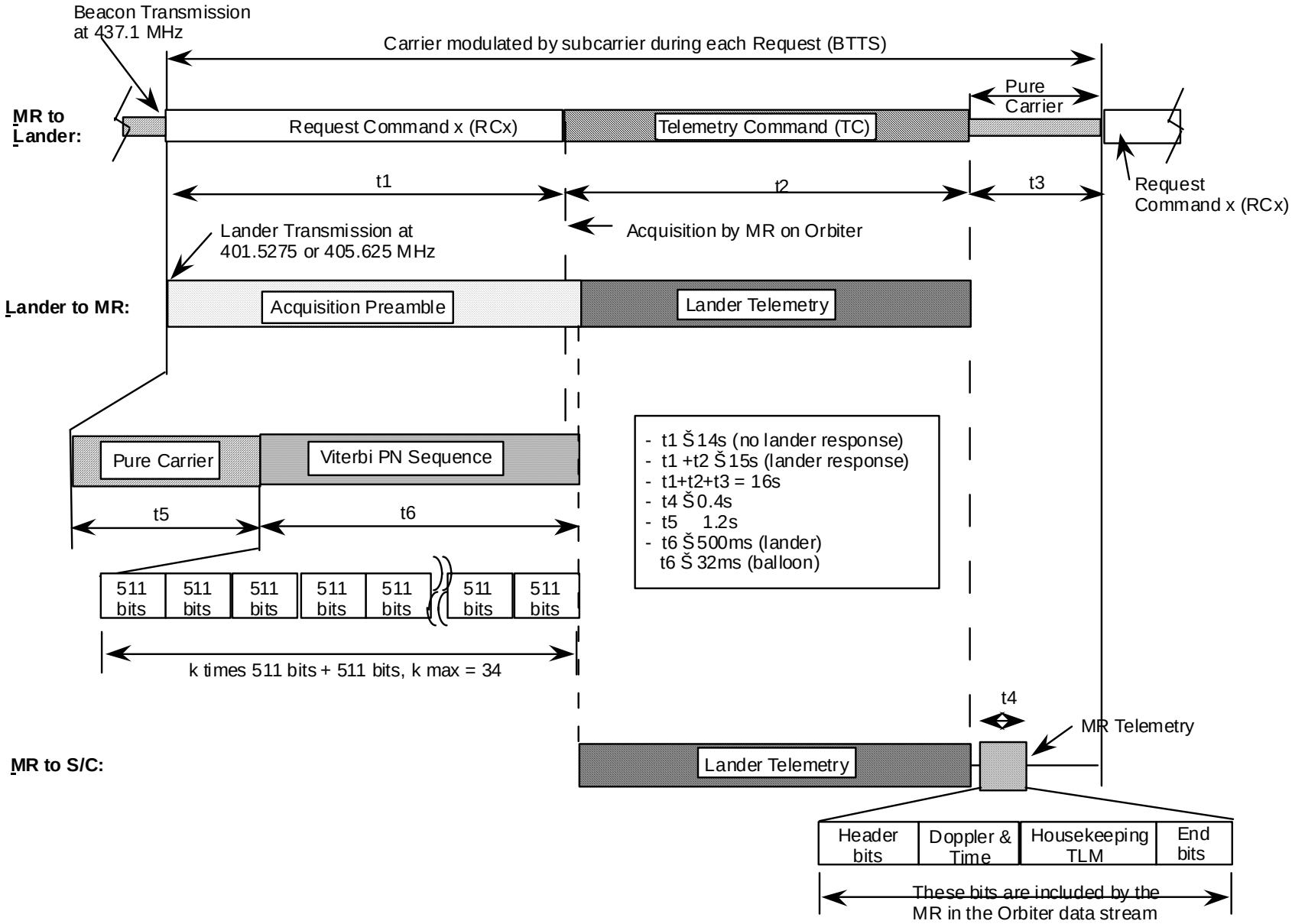

Figure 3-1 Link Protocol